A Versatile, 1-Dimensional Climate Model for the Virtual Planetary Laboratory

G. Tinetti
NASA-Astrobiology-Institute/National Academies
Caltech/IPAC/SSC MS 220-6
1200 E. California, 91125 Pasadena, CA
USA
tinetti@ipac.caltech.edu

D. Crisp
NASA-JPL
USA

V. Meadows
NAI-Caltech
USA

A 1-dimensional radiative convective equilibrium climate model is being developed to simulate the environments of plausible extrasolar terrestrial planets. This model will be incorporated with atmospheric chemistry, geology, biology, and exogenic process models to form heart of the Virtual Planetary Laboratory. While a 1-D climate model provides only a globally-averaged description of the planet's surface temperature and atmospheric thermal structure, this model is being designed to incorporate a rigorous description of physical processes controlling the vertical transport of heat and volatiles to maximize its versatility and range of validity. Radiative heating and cooling rates are generated with the Spectral Mapping Atmospheric Radiative Transfer (SMART) model. This model incorporates a "line-by-line" description of gas absorption with a multi-layer, multi-stream multiple scattering algorithm to provide a comprehensive description of solar and thermal radiative transfer in realistic scattering, absorbing, emitting atmospheres. The vertical convective heat and volatile transport is simulated by a mixing length formulation based on a state-of-the-art planetary boundary layer model. Diffusive heat transport within the surface and near-surface atmosphere is simulated by a multi-layer vertical heat diffusion model. We are currently in the process of incorporating a versatile cloud/aerosol model that simulates airborne particle nucleation, condensation, evaporation, coagulation, and precipitation of any species identified as an active volatile or passive aerosol (dust) in the climate system. Once validated, this simple climate model will be used to simulate the environments of terrestrial planets that have a range of atmospheric and surface compositions, orbiting stars with different stellar types.